

ART. VIII. A REVIEW OF THE XIPHOSURAN GENUS
BELINURUS WITH THE DESCRIPTION OF A NEW
SPECIES, *B. ALLEGANYENSIS*.

By E. R. ELLER

(PLATES IX-XIV)

INTRODUCTION

An interesting specimen of a Xiphosuran was uncovered in a plantation of *Prismodictya telum* James Hall, in the Edwin Bradford Hall collection of Upper Devonian Reticulate Sponges. The specimen is from the Upper Devonian (Conneaut Group*) at Wellsville, Allegany County, New York. The Xiphosuran, together with the sponges, is preserved in an impure sandstone and shows little evidence of having been crushed or distorted. Other typical Upper Devonian marine forms are found in the adjacent strata. The specimen belongs to the genus *Belinurus* and is probably the oldest form known for America and perhaps antedates the European species *Belinurus killtorkensis* Baily. Only one other species of the genus, *Belinurus grandævus* Jones and Woodward, from the Carboniferous, Riverdale formation of Nova Scotia, has so far been found or described from America.

The writer wishes to express his thanks, for their valuable suggestions in the study of this form, to Professor Carl O. Dunbar of Yale University and to Dr. I. P. Tolmachoff of the Carnegie Museum.

DESCRIPTION OF SPECIES

***Belinurus alleganyensis* sp. nov.**

(Plate IX, figs. 1, 2)

The body is highly convex and similar in shape to the modern kingcrab or horseshoe crab, *Limulus*. The dimensions of the specimen, irrespective of the telson, are as follows: length 41.3 mm., width 46.4 mm., and height about 11 mm. The form, therefore, is rather

*Personal communication with Professor John G. Woodruff.

large for *Belinurus*, being larger than any other specimen known to the writer.

The cephalothorax is semi-elliptical, except for the anterior margin which is more or less straight. The posterior margin is symmetrically waved with a backward curve to the rachial furrow of the abdomen where the margin curves forward and then backward to form a point opposite the middle of the rachis. The genal spines are stout and extend backward to a point opposite the fourth pleural segment of the abdomen.

The cardiac lobe is irregularly triangular in outline, elevated and rounded, thus having no distinct median line. Posteriorly the lateral

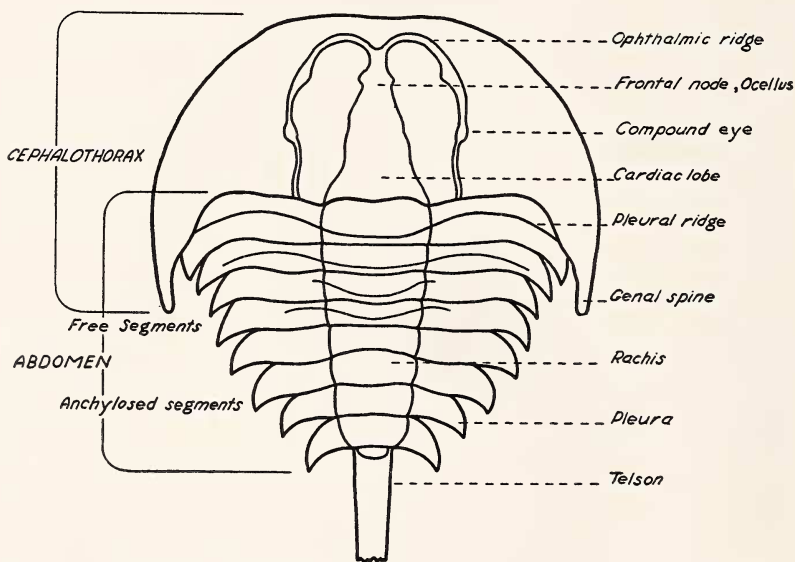


FIG. 1. Schematic representation of the Belinuridae.

margins exhibit a wave-like outline to the apex. Slightly anterior to the middle, the lobe is crossed by a forward-curving furrow and there is also an indication of three other furrows on the lobe. On the anterior end the cardiac lobe bears a sharply defined frontal node, a trefoiled club-like structure from which extends the ophthalmic ridge. Perhaps this structure contained the ocelli. The ridges are strongly elevated and curve to the posterior margin of the cephalothorax. The

furrows of the cardiac lobe, if they are not caused in the process of fossilization, would divide the cardiac lobe into five parts which, along with the frontal node, would suggest the presence of six limbs similar to those of the modern *limulus*. The ophthalmic ridges slope abruptly to the margins of the carapace but gradually to the cardiac lobe, except at the anterior part where a deeper area is found. At the lower end of this depressed area, the ophthalmic ridge has widened and forms a node-like structure which, together with the frontal node at the end of the cardiac lobe, nearly encloses, or better emphasizes this depression. An irregular impression, probably of the compound eye, is located posteriorly to the middle part of the ridge.

The abdomen is broadly convex and irregularly triangular in shape. There are eight segments well defined by deep grooves. The first six are probably movable and the remaining two anchylosed. On each side of the telson, which is, however, only partly preserved in the specimen, on the last segment are node-like projections which, perhaps, were functional in the articulation of the telson, or which may have been the bases of spines. On each of the first four segments near the posterior edge is a pleural ridge which in the first segment is highly elevated and extends the full length of the segment but which gradually becomes shorter and less pronounced in the remaining three. The first three articulated segments appear to be distinctly truncate and have large, round, and slightly raised areas at their ends. Perhaps these raised structures are for the articulation of movable spines. The rachis is highly elevated. The two, well defined, anchylosed segments, separated from the movable segments by a groove, are decidedly different in form from the proceeding ones. The first one is twice as wide as the last one and is crossed by a groove which gives a slight concavity to the segment. Whether this groove is actually a suture and constitutes true segmentation remains undecided. The last segment is small and is separated by a less well defined groove than that between the free and anchylosed segments.

DISCUSSION

Devonian *Limuloids* are usually found in marine deposits while Carboniferous and Permian forms are limited to fresh or brackish water deposits. During Jurassic times *Limulus*, as a form not unlike that living today, was again found in marine deposits. If the place of burial was also the habitat, it is interesting to note that the habitat

of the *Limulida* changed from marine to fresh water and then back to a marine environment. Possibly these changes in habitat, whether forced by a changing environment or by migration, stimulated and then arrested their evolution, thus making forms of *Limulida* good examples of persistent types.

The Carnegie Museum has specimens of *Belinurus bellulus* König and another specimen labeled *Belinurus kænigianus* Woodward, from the Carboniferous of England, which resemble *Belinurus alleganyensis* m. in certain details of the cephalothorax. The similarity is expressed mostly in the cardiac lobe, the frontal node, and the ophthalmic ridge. However, the general shape of the cephalothorax and the anchylosed segments of the abdomen are different. On cleaning *Belinurus kænigianus* Woodward, which is figured on Plate IX, fig. 3, it was found that long spines were preserved. *Belinurus kænigianus* Woodward does not bear genal spines in any of the illustrations (Plate XI, figs. 1, 2) seen by the writer but these show the genal angles to be rather obtuse. This bluntness of the genal angles is also mentioned in the descriptions of the species. In other respects, except for a wider rachis, the specimen, Plate XI, fig. 3, corresponds closely to *Belinurus kænigianus* Woodward. Possibly the genal angles of some individuals were blunt while others developed spines or perhaps the spines were commonly broken off during life or in burial. Due to the lack of comparative material, the writer feels unable to decide if this form is a new species and thus, for the present, will consider it as *Belinurus kænigianus* Woodward.

Belinurus grandævus Jones and Woodward, 1899,¹ Plate XII, figs. 7, 8, from the Carboniferous of Nova Scotia is similar in outline to *Belinurus alleganyensis* m. but the details of the Nova Scotia form are so little known that a comparison is difficult. *Belinurus kiltorkensis* Baily, Plate XIV, figs. 4-7, of the Upper Old Red Sandstone of Ireland is based on two extremely fragmentary specimens, one of which is badly distorted. Baily first described the specimens in 1869, Woodward, 1878, re-described and published figures, and Cole, 1901, also re-described and published new figures of the same specimens. These several figures do not agree very well and the descriptions are so general that there is some doubt in the mind of the writer as to their identification. For these reasons no comparisons will be attempted.

¹ All species attributed to *Belinurus*, known and available to the writer, are figured on Plates IX, X, XI, XII, XIII, and XIV.

Dix and Pringle, 1929, 1930, described five new species of *Belinurus*, Plate XI, figs. 7, 9, Plate XII, figs. 2, 5, 6, 9, from the Carboniferous of the South Wales Coal Field. These species resemble *Belinurus alleganyensis* m. in a general way. A fragment of the cephalothorax of *Belinurus pustulosus* Dix and Pringle, Plate XII, fig. 9, for which the authors have some doubt as to its true affinity, suggests segmentation of the cardiac lobe. Since there is perhaps a slight segmentation in the same area of *Belinurus alleganyensis* m. it would be interesting to make a closer comparison between these two forms.

Belinurus reginae Baily, 1863, Plate X, figs. 1, 2, *Belinurus arcuatus* Baily, 1863, Plate XI, figs. 3-6, *Belinurus silesiacus* Roemer, 1883, Plate XII, figs. 3, 4, *Belinurus lunatus* Baldwin, 1907, Plate XIV, fig. 3, *Belinurus baldwini* Woodward, 1907, Plate XIV, fig. 1, and *Belinurus longicaudatus* Woodward, 1907, Plate XIV, fig. 2, are comparable to *Belinurus alleganyensis* m. in a general way.

The general shape of the cephalothorax, the cardiac lobe, and the ophthalmic ridge of *Paleolimulus avitus* Dunbar, 1923, compare rather favorably with *Belinurus alleganyensis* m. If the four, slightly raised structures in the depressed areas between the cardiac lobe and the ophthalmic ridge of *Belinurus alleganyensis* m. were actually nodes, and, if the node on each side of the frontal node at the apex of the cardiac lobe would be taken into consideration, the form would lack only one node of the necessary six to correspond with the six thoracic limbs of the modern *Limulus* and to be somewhat similar to the same structural detail of *Paleolimulus avitus* Dunbar.

Matthew, 1909, created a new genus, *Belinuropsis*, for a species *Belinuropsis wigodensis* Matthew, Plate XIV, fig. 9, from the Little River Group, at Duck Cove, Lancaster, N. B. This form is however so fragmentary that no good comparison can be made with *Belinurus alleganyensis* m.

In 1933, Chernyshev described from the Upper Devonian, Don River, U. S. S. R., *Bellinuropsis rossicus* Chernyshev, a limuloid, new generically and specifically. Chernyshev's species, which is reproduced on Plate XIV, fig. 8, is well preserved but only comparable to *Belinurus alleganyensis* m. in a general way. The generic name used by Chernyshev was already pre-occupied by Matthews for an entirely different form and therefore should be replaced by a new one, for which the author suggests

***Neobelinuropsis* nom. nov.**

The following diagnosis of the genus *Belinurus* König is a revision by Professor Dunbar, 1923, published in conjunction with his paper on a new genus of paleozoic *Xiphosura*:

Belinurus: "Body limuloid in shape. Abdomen triangular, distinctly trilobed, consisting of eight segments plus a slender ensiform telson. The first five segments movably articulare, the last three anchylosed."

Dix and Pringle, 1929, gave the following diagnosis for the genus:

Belinurus: "Body limuloid, head-shield or prosoma semi-circular with long genal spines from the posterior angles. Median part of prosoma (glabella) prominent and divided into two lobes, declining toward the circumference and surrounded by a narrow, flattened margin. Mesasoma, consisting of five free segments, each produced laterally into spines. Metasoma small, formed of three fused segments, and a long telson. Genoholotype, *Belinurus bellulus* König."

Several of the species described by Dix and Pringle, 1929, 1930, Plate XI, figs. 7, 9, Plate XII, figs. 2, 5, 6, 9, do not correspond with the above diagnosis of the genus in the number of abdominal segments. In the first paper *Belinurus truemanni* D. & P., in which the abdomen is poorly preserved, is thought to have four free and three anchylosed segments; in the second paper, where the species is described from a specimen in which the abdomen is better preserved, five free and two anchylosed segments are shown to be present. *Belinurus concinnus* D. & P., shows six free segments, the anchylosed segments being indiscernible. *Belinurus carnayensis* D. & P., has five free and two anchylosed segments, while *Belinurus morgani* D. & P., is shown to have seven free and two anchylosed.

B. alleganyensis m. likewise does not correspond in all details with the above qualifications of the genus in the abdominal region, since it apparently has six movable and two anchylosed segments. The writer is doubtful about the generic position of *Belinurus alleganyensis* m. but, for several reasons, the separation of it under a new generic name does not seem advisable at the present time. In making a general comparison of *Belinurus alleganyensis* m. with the known species of the genus *Belinurus*, it is evident that there is a common likeness or relationship between them. The fact that *Belinurus alleganyensis* m. is larger and older geologically than the Carboniferous species does not, at least in the mind of the writer, alone signify any valid reason for a generic difference. It would follow, then, that the diagnosis of the genus *Belinurus* should be made more elastic as to the number of segments of the abdomen.

Belinurus, Diagnosis: Body limuloid in shape. Cephalothorax semi-circular usually with post-lateral genal spines, prominent cardiac lobe, and paired ophthalmic ridges bearing compound eyes. Abdomen triangular, distinctly trilobed, consisting of seven or more segments bearing lateral spines, and a slender ensiform telson. The first four or more segments are movably articulated, the last two or more anchylosed.

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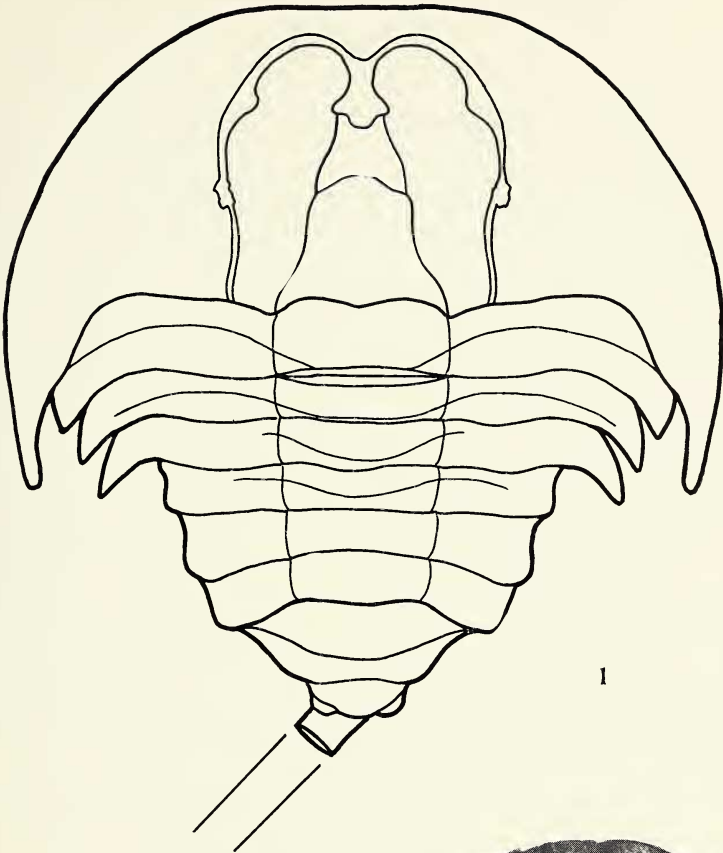
EXPLANATION OF PLATE IX

FIG. 1. *Belinurus alleganyensis* sp. nov. $\times 2$. Drawing of fig. 2. Upper Devonian, Wellsville, N. Y.

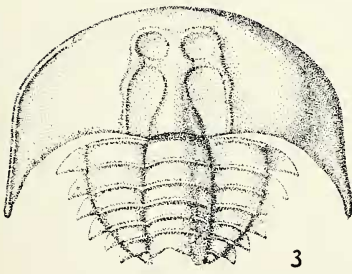
FIG. 2. *Belinurus alleganyensis* sp. nov. Natural size. Upper Devonian, Wellsville, N. Y.

The type is in the Carnegie Museum, Number 11065, Section of Invertebrate Paleontology.

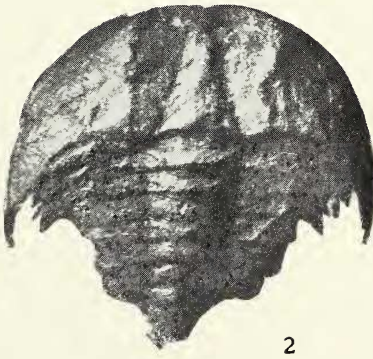
FIG. 3. *Belinurus kænigianus* Woodward. Natural size. Coal Measures, Carboniferous, Caseley, England.



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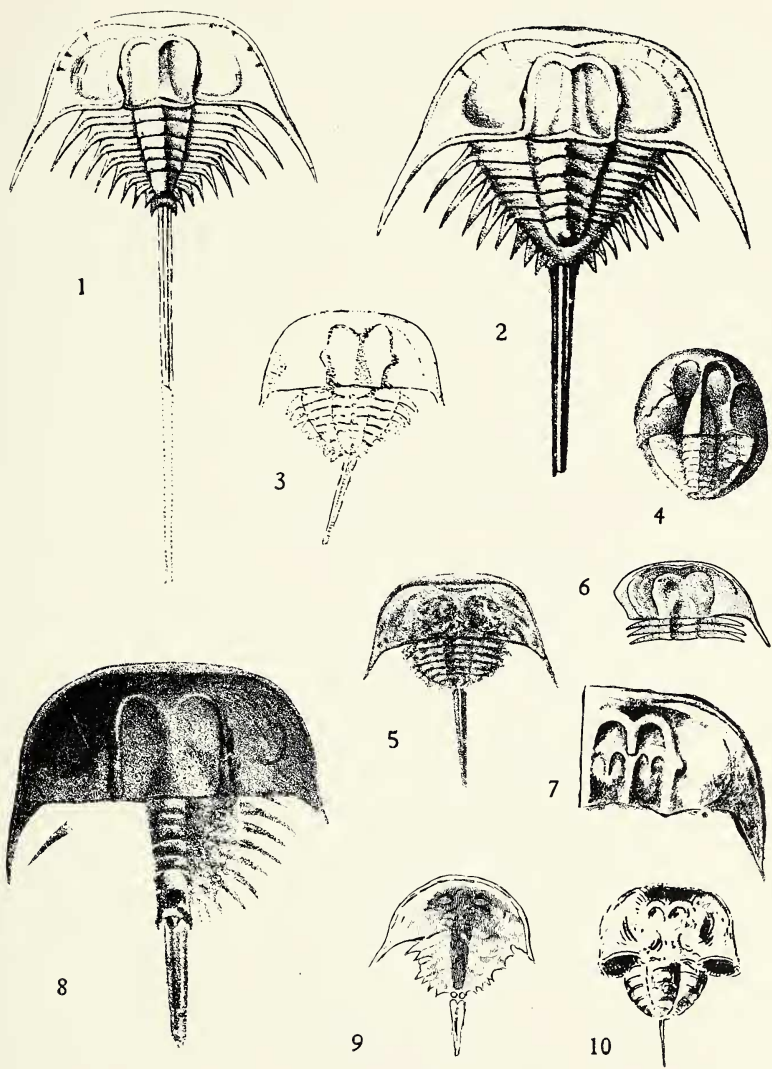
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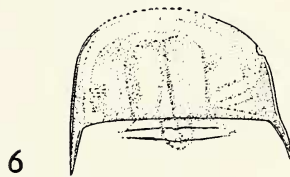
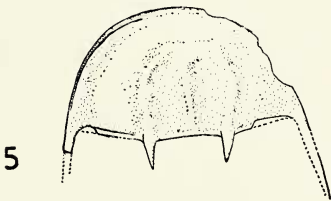
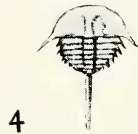
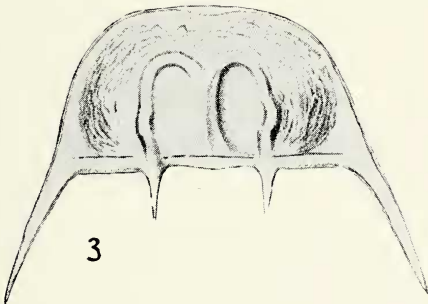
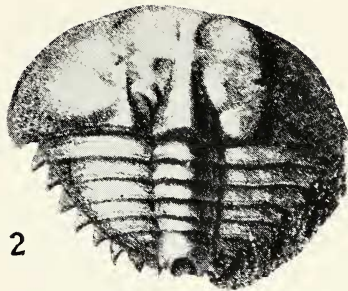
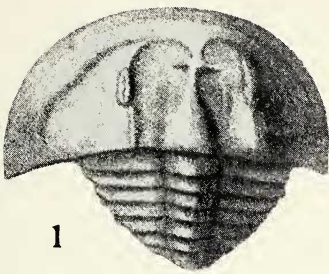
EXPLANATION OF PLATE X

- FIG. 1. *Belinurus reginæ* Baily. Enlarged. From British Fossil Crust., Paleon. Soc., pl. 31, fig. 16, 1866-1876.
- FIG. 2. *Belinurus reginæ* Baily. Enlarged. From Quat. Jour. Geol. Soc., London, Vol. 23, pl. 1, fig. 1, 1867.
- FIG. 3. *Belinurus bellulus* König, $\times 3$. From Ann. Nat. Hist., Vol. 6, p. 140, fig. 3, 1930.
- FIG. 4. *Belinurus bellulus* König. From Geol. of Londonderry, p. 316, pl. 24, fig. 11, 1843.
- FIG. 5. *Belinurus bellulus* König. From British Fossil Crust., Paleon. Soc. pl. 31, fig. 3b. 1866-1878.
- FIG. 6. *Belinurus bellulus* König, $\times \frac{2}{3}$. From Summary of Progress. Geol. Surv. Gr. Britain, pt. 2, p. 97, fig. 5. 1928.
- FIG. 7. *Belinurus bellulus* König, $\times \frac{2}{3}$. From Trans. Manchester Geol. and Min. Soc., Vol. 28, pp. 198-202, 1903.
- FIG. 8. *Belinurus bellulus* König, $\times 1\frac{1}{2}$. From British Fossil Crust., Paleon. Soc., pl. 31, fig. 3a, 1866-1878.
- FIG. 9. *Belinurus bellulus* König. From Bridgewater Treatise, Vol. 2, pl. 46, 1836.
- FIG. 10. *Belinurus bellulus* König. From Petrificata Derbiensia, pl. 45, fig. 4, 1809.



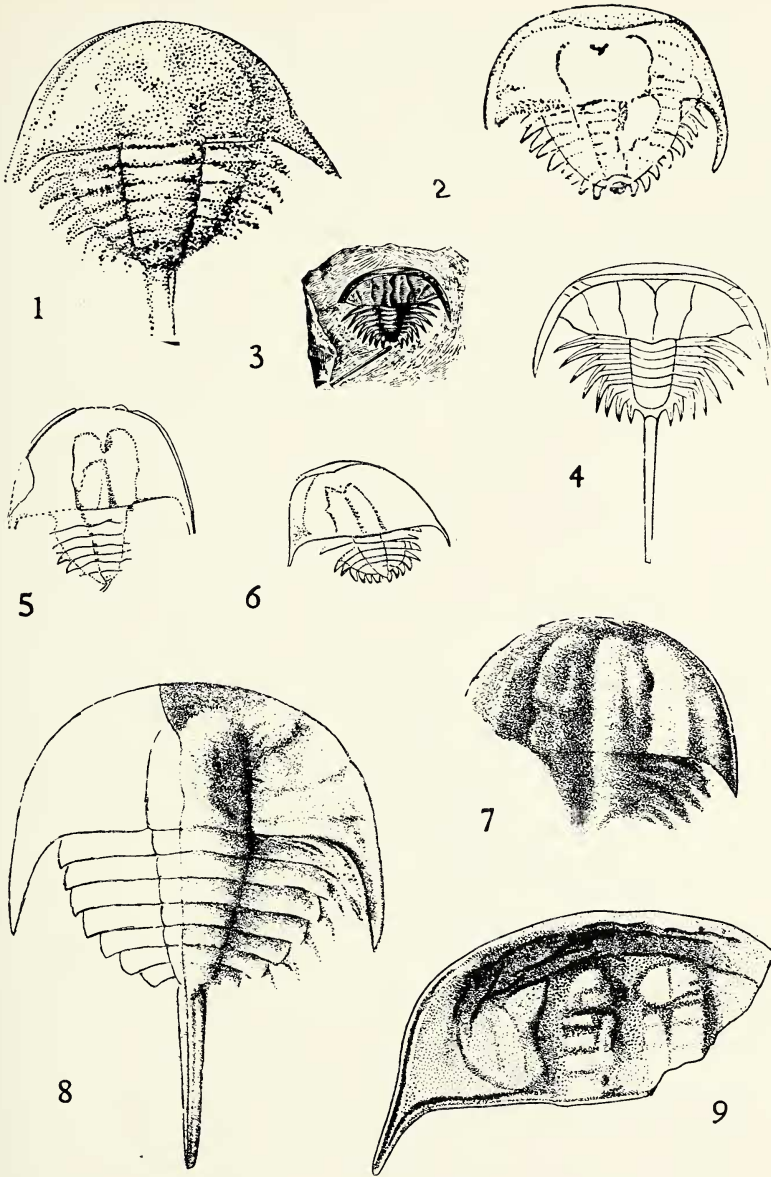
EXPLANATION OF PLATE XI

- FIG. 1. *Belinurus kænigianus* Woodward. Enlarged. From British Fossil Crust., Paleon. Soc., pl. 31, fig. 3c, 1866-1878.
- FIG. 2. *Belinurus kænigianus* Woodward. Enlarged. From British Fossil Crust., Paleon. Soc., pl. 31, fig. 4, 1866-1878.
- FIG. 3. *Belinurus arcuatus* Baily. Enlarged. From British Fossil Crust., Paleon. Soc., pl. 31, fig. 2b, 1866-1878.
- FIG. 4. *Belinurus arcuatus* Baily. $\times 1\frac{1}{4}$. From British Fossil Crust., Paleon. Soc., pl. 31, fig. 2a, 1866-1878.
- FIG. 5. *Belinurus* cf. *arcuatus* Baily. $\times 2\frac{1}{2}$. From Summary of Progress. Geol. Surv. Gr. Britain, pt. 2, p. 99, fig. 7, 1928.
- FIG. 6. *Belinurus arcuatus* Baily. $\times 2$. From Summary of Progress. Gr. Britian, pt. 2, p. 98, fig. 6. 1928.
- FIG. 7. *Belinurus truemani* Dix & Pringle. $\times 3\frac{1}{4}$. From Summary of Progress. Geol. Surv. Gr. Britain, pt. 2, p. 95, fig. 3. 1928.
- FIG. 8. *Belinurus kænigianus* Woodward. $\times 1\frac{1}{2}$. From Summary of Progress. Geol. Surv. Gr. Britain, pt. 2, p. 100, fig. 8. 1928.
- FIG. 9. *Belinurus* cf. *truemani* Dix & Pringle. $\times 3\frac{1}{4}$. From Ann. Nat. Hist., Ser. 10, Vol. 6, p. 139, fig. 2. 1930.



EXPLANATION OF PLATE XII

- FIG. 1. *Belinurus trechmanni* Woodward. $\times 4$. From Geol. Mag., Dec. 6, Vol. 5, pp. 462-471, fig. 5, 1918.
- FIG. 2. *Belinurus morgani* Dix & Pringle. $\times 3$. From Ann. Nat. Hist., Ser. 10, Vol. 6, p. 138, fig. 1, 1930.
- FIG. 3. *Belinurus silesiacus* Roemer. $\times \frac{3}{4}$. From Zeitschr. d. Deut. Geol. Gesell. Bd. 35, pp. 429-432, fig. 1, 1883.
- FIG. 4. *Belinurus silesiacus* Roemer. Enlarged. From Zeitschr. d. Deut. Geol. Gesell. Bd. 35, pp. 429-432, fig. 2, 1883. Restoration of fig. 1.
- FIG. 5. *Belinurus concinnus* Dix & Pringle. $\times 1$. From Summary of Progress. Surv. Gr. Britain, pt. 2, p. 92, fig. 1, 1929.
- FIG. 6. *Belinurus carwayensis* Dix & Pringle. $\times 1$. From Summary of Progress. Geol. Surv. Gr. Britain, pt. 2, p. 94, fig. 2, 1929.
- FIG. 7. *Belinurus grandævus* Jones & Woodward. $\times 7$. From Geol. Mag., Dec. 4, Vol. 6, pl. 15, fig. 3. 1899.
- FIG. 8. *Belinurus grandævus* Jones & Woodward. $\times 7$. From Geol. Mag., Dec. 4, Vol. 6, pl. 15, fig. 2, 1899.
- FIG. 9. *Belinurus pustulosus* Dix & Pringle. $\times 2$. From Summary of Progress. Geol. Gr. Britain, pt. 2, p. 96, fig. 4, 1928.



EXPLANATION OF PLATE XIII

- FIG. 1. *Belinurus metschelnensis* Chernyshev. $\times 3\frac{1}{2}$. From Bull. du Comité Géol., Vol. 46, p. 35, fig. 5, 1927.
- FIG. 2. *Belinurus metschelnensis* Chernyshev. $\times 3\frac{1}{2}$. From Bull. du Comité Géol., Vol. 46, pl. 35, fig. 4, 1927.
- FIG. 3. *Belinurus iswarinensis* Chernyshev. $\times 2$. From Bull. du Comité Géol., Vol. 46, pl. 35, fig. 10, 1927.
- FIG. 4. *Belinurus stepanovi* Chernyshev. $\times 3\frac{3}{4}$. From Bull. du Comité Géol., Vol. 46, pl. 35, fig. 7, 1927.
- FIG. 5. *Belinurus iswarinensis* Chernyshev. $\times 2\frac{1}{2}$. From Bull. du Comité Géol., Vol. 47, pl. 37, fig. 16, 1928.
- FIG. 6. *Belinurus stepanovi* Chernyshev. $\times 3\frac{1}{2}$. From Bull. du Comité Géol., Vol. 46, pl. 35, fig. 6, 1927.
- FIG. 7. *Belinurus iswarinensis* Chernyshev. From Bull. du Comité Géol., Vol. 46, p. 649, text fig. 1, 1927.
- FIG. 8. *Belinurus iswarinensis* Chernyshev. $\times 3\frac{1}{2}$. From Bull. du Comité Géol., Vol. 46, pl. 35, fig. 2, 1927.



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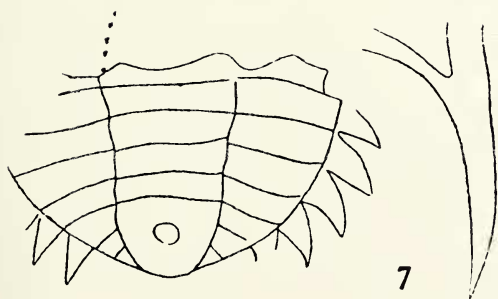
4



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8

EXPLANATION OF PLATE XIV

- FIG. 1. *Belinurus baldwini* Woodward. $\times 3$. From Geol. Mag., Dec. 5, Vol. 8, pp. 540-541, fig. 1, 1908.
- FIG. 2. *Belinurus longicaudatus* Woodward. $\times \frac{3}{4}$. From Geol. Mag., Dec. 5, Vol. 8, pp. 540-541, fig. 2, 1907.
- FIG. 3. *Belinurus lunatus* Baldwin. $\times 1$. From Trans. Manchester Geol. and Min. Soc., Vol. 29, p. 126, fig. 2, 1904.
- FIG. 4. *Belinurus kiltorkensis* Baily. From Geol. Mag., Dec. 4, No. 440, p. 52, fig. 2, 1901.
- FIG. 5. *Belinurus kiltorkensis* Baily. From Geol. Mag., Dec. 4, No. 440, p. 52, fig. 1, 1901.
- FIG. 6. *Belinurus kiltorkensis* Baily. Enlarged. From British Fossil Crust., Paleon. Soc., p. 238, fig. 79b, 1866-1878.
- FIG. 7. *Belinurus kiltorkensis* Baily. Enlarged. From British Fossil Crust., Paleon. Soc., p. 238, fig. 79a, 1866-1878.
- FIG. 8. *Neobelinuropsis rossicus* (Chernyshev). $\times \frac{3}{4}$. From Materials of the Centr. Geol. and Prospecting Inst., Paleon. and Strat., Mag. 1, pp. 15-24, 1 pl., fig. 1, 1933.
- FIG. 9. *Belinuropsis wigodensis* Matthew. Enlarged. From Trans. Roy. Soc. Canada, Ser. 3, Vol. 3, Sect. 4, pp. 115-125, fig. 3, 1909.

